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AIR QUALITY STUDY IN THE VICINITY OF HIGHLAND CREEK SEWAGE TREATMENT PLANT SCARBOROUGH JUNE 1987

ARB-138-87-ARSP

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Ministry of the Environment
Ontario

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Air Resources Branch

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Prepared for
the Central Region
Ministry of the Environment

by

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TABLE OF CONTENTS

Executive Summary

A mobile air monitoring unit (MAMu #2) from the Air Resources Branch made air quality measurements in late June 1987 in the vicinity of the Highland Creek Sewage Treatment Plant in Scarborough.

The purpose of the study was to determine if the ambient air concentrations of a large number of organic compounds and common contaminants were high enough to be the cause of odour problems or exceed the Ontario ½-hour point of impingement standards/guidelines.

On the sewage plant property, elevated concentrations of total reduced sulphur (TRS) compounds and total hydrocarbons (THC) from the primary clarifiers and the screen/degrit building, where raw sewage enters the plant, were found to be the most likely sources of odour. For most of the samples collected on plant property, toluene was the main component identified by gas chromatography. However, its observed concentrations were always well below the Ontario ½-hour standard.

1,2,4-trimethylbenzene was the only compound to exceed the standard (100 $\mu g/m^3$) at the screen building, with a concentration of 171 $\mu g/m^3$.

Monitoring in the residential areas showed low levels of all contaminants, except at times with contributions from local vehicle emissions.

Toluene and xylenes were shown to be the major contaminants during two periods when sampling was carried out downwind of Valspar, Inc. in the industrial area; however, the concentrations did not exceed or approach the Ontario standards.

Résumé

À la fin de juin 1987, une analyse de la qualité de l'air a été effectuée dans les environs de l'usine d'épuration des eaux d'égout du ruisseau Highland, à Scarborough, à l'aide d'une unité mobile de surveillance de l'air (n° 2) de la Direction des ressources atmosphériques.

L'objectif de l'analyse était de vérifier si les concentrations dans l'air ambiant d'un grand nombre de composés organiques et de polluants communs étaient assez élevées pour causer des problèmes d'odeur, et si elles dépassaient les normes ou les lignes directrices ontariennes pour une période d'une demi-heure.

Sur les terrains de l'usine d'épuration, il est ressorti que des concentrations élevées de composés de soufre réduit total (SRT) et d'hydrocarbures totaux (HT) observées aux clarificateurs primaires et aux installations de dégrillage et de dessablage, par où passent les eaux d'égout brutes entrant dans l'usine, constitueraient les sources les plus probables des odeurs. Dans la plupart des échantillons prélevés sur le terrain de l'usine, le toluène a été le principal élément révélé par chromatographie en phase gazeuse. Cependant, les concentrations observées pour cette substance étaient toujours de beaucoup inférieures à la norme ontarienne pour une demi-heure.

Le 1,2,4-triméthyl benzène s'est révélé le seul composé excédant la norme (100 ug/m^3) à l'installation de dégrillage; sa concentration s'élevait à 171 ug/m^3.

En zone résidentielle, les concentrations de tous les polluants se sont révélées faibles. Cependant, elles étaient parfois plus élevées en raison des émissions des véhicules.

Le toluène et les xylènes ont été les principaux polluants détectés dans des échantillons prélevés à deux reprises sous le vent par rapport à Valspar Inc., dans le secteur industriel; cependant, les concentrations de ces substances étaient de beaucoup inférieures à celles qui sont prescrites par les normes ontariennes.

1.0 Introduction

At the request of the Central Region, air quality measurements were made by the Air Resources Branch with a mobile air monitoring unit (MAMu #2) in late June 1987 in the vicinity of the Highland Creek Sewage Treatment Plant (S.T.P.) in Scarborough. The plant is located at the mouth of Highland Creek as it enters Lake Ontario. In the residential areas on both sides of the creek within 1.5 kilometers of the S.T.P., there is an increased awareness of the S.T.P. and a perception that some "change" at the S.T.P. has caused (during the past 18 months) the strongest, most frequent odours since approximately 15 years ago.

A record of odour complaints from residents in the neighbourhood is maintained at the S.T.P. For the period May 1 - June 15, 1987, there were complaints on 31 of the 46 days (67%).

The purpose of the study was to measure the ambient air concentrations of a large number of organic compounds and common contaminants and to determine if any measured concentrations were high enough to cause odour problems or exceed the Ontario $\frac{1}{2}$-hour point-of-impingement standard/guidelines.

2.0 MAMu #2 and Survey Technique

MAMu #2 contains analyzers for monitoring carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO_2), methane (CH_4) and non-methane (TH-M) components of total hydrocarbons (THC), ozone (O_3), sulphur dioxide (SO_2), total reduced sulphur compounds (TRS) including hydrogen sulphide (H_2S), and a large number of organic compounds using a gas chromatograph (GC).

The gas chromatograph is coupled to an organic compounds preconcentrator of our own design. Compounds detectable by the system include

alkanes, alkenes, alkynes, aromatics and chlorinated hydrocarbons. Typical detection limits are in the 0.1-1.0 ug/m^3 range. A useful parameter from the GC results was the total organic compounds (TOC) concentration.

MAMu #2 was also outfitted with meteorological instrumentation to measure wind speed and direction, temperature, barometric pressure and solar radiation.

The analyzers were checked (calibrated) each day before moving the MAMu #2 to a monitoring area downwind of the S.T.P. The sampling period for each of the GC samples was 30 minutes long so that the results could be directly compared to Ministry standards and guidelines.

The plume from the incinerator stack was not accessible for monitoring during the survey period.

When monitoring in the residential areas was not feasible because of improper wind conditions - wrong direction or too calm - then air samples were taken at various points on the S.T.P. property for reference purposes.

Brief sampling was done in the industrial area 0.5 kilometer west of the S.T.P. because chemical odours were believed to originate from there.

3.0 Results and Discussion

The monitoring locations, periods and results summary are displayed in Table 1. Table 2 lists the detailed GC results of each sample for the individual compounds and for the groups of compounds (such as alkanes, aromatics, etc.)

During the 10 days of active monitoring (June 15-19, 22-26), there were 16 daytime and 8 overnight (no GC samples) monitoring periods. The 16 daytime periods comprised: 3 periods at the shoreline power site

beside one of the secondary clarifiers (final settling); 7 periods near primary clarifiers, digesters and degrit/screen building; 4 periods in the residential area downwind of the S.T.P.; and 2 periods in the industrial area (west of the S.T.P.) downwind of Valspar Incorporated.

3.1 S.T.P. Property

For the 10 daytime periods on the S.T.P. property, the highest ½-hour average concentrations of TRS (0.362 ppm) and CO (9.0 ppm) were found near the degrit/screen building, where the raw sewage enters the S.T.P. complex. The THC were fairly high also (21.6 ppm, mostly non-methane) and were supported by a high TOC level on the gas chromatograph.

There were two periods when ozone concentrations were above the half-hour standard (0.10 ppm) at the shoreline power location on S.T.P. property. On June 19, a concentration of 0.15 ppm (max ½-hour average) ozone was reached while there were concurrent slightly elevated levels of methane, total hydrocarbons, sulphur dioxide and total reduced sulphur compounds. Light westerly winds were present and may have carried some of the ozone from the screen building or other areas where ozone is used in the treatment processes of the S.T.P. However, most of the ozone was due to long-range transport, since elevated ozone levels ranging from 0.113 to 0.137 ppm were detected across Metro Toronto in the afternoon. On June 25, the ozone concentrations were slightly above (0.11 ppm) or below the standard for most of the late afternoon and evening period while all other contaminants were very low and wind conditions were variable. It appears that most of the ozone for this period was also due to long-range transport since Metro Toronto levels were in the range of 0.085 to 0.091 ppm.

Samples near the primary clarifiers also showed elevated levels of TRS (0.031, 0.040, 0.056 ppm) and THC (17.5, 41.2, 48.0 ppm), but the THC was mainly methane, which explained the low level of TOC (which excludes methane).

Sampling downwind of the sludge digesters showed TRS levels of 0.011 ppm and THC levels at 13.9 ppm (mostly methane) with very low TOC.

Samples collected near the secondary clarifier while the MAMu was on shoreline power showed generally low levels of all contaminants.

During the late part of period B222 a sample was taken at the vent of an underground passageway (referred to as a "galley" by an S.T.P. employee). The vent was at the edge of the primary clarifier nearest to the north side of the screen building. The TOC level was higher than that of primary clarifier samples and was very similar in profile (relative percentage of contaminants) to that of the screen building samples.

Some general observations can be made about the GC results on the S.T.P. property. For most samples, the per cent aromatics was approximately equal to the per cent alkanes, which varied from 30% to 50% of the TOC.

The main component in most samples was toluene, but the highest toluene concentration (296 ug/m^3 at the screen building) was much less than the $\frac{1}{2}$-hour standard in Ontario (2000 ug/m^3). The per cent chlorinated alkanes (mainly dichloromethane and 1,1,1-trichloromethane) were noticeably higher on S.T.P. property than outside, which seems logical considering the prominent use of chlorine at any S.T.P.

It should be noted that the only organic compound to exceed an Ontario standard on plant property was 1,2,4-trimethylbenzene (171 µg/m^3 at the screen building; standard = 100 ug/m^3). Off the property, all air measurements were below Ontario's standards.

3.2 Residential Area

There were frequent, daily tours through the residential areas during the survey period by one of the monitoring crew, usually in response to a phoned-in odour complaint or in anticipation of the appropriate wind conditions carrying sewage odours. On the few occasions when odours were detected, they were fleeting in nature and very weak in intensity - as perceived by the monitoring personnel.

Monitoring in the residential areas were attempted on four days. The concentrations of TRS (≤.003 ppm) and O_3 (≤.07 ppm) were always low, while CO and THC levels were slightly elevated at times which were easily explained by vehicle local emissions (evaporative and exhaust).

3.3 Industrial Area

There were two periods (B242, B262) when monitoring was done in the industrial area along Coronation Drive in the presence of aromatic odours. MAMu #2 was located downwind of the Valspar (Inc.) Coatings Division plant where xylene and toluene are two of the most frequently used raw materials.

The concentration of total organic compounds (TOC) as determined by the GC was above background levels at 1190 and 1438 $\mu g/m^3$. Total xylene (m-, p- and o-) levels of 275.4 and 533.3 $\mu g/m^3$ were the main components measured, but were still well below the Ontario $\frac{1}{2}$-hour provisional guideline of 2300 $\mu g/m^3$ for total xylenes. Toluene had the next highest concentration for period B242 at a level of 198.9 $\mu g/m^3$, well below the $\frac{1}{2}$-hour standard of 2000 $\mu g/m^3$. Toluene and xylenes are in the class of aromatic compounds, which altogether formed 60% of the TOC level for both periods. In comparison, the per cent aromatics for the residential and S.T.P. locations was in the range of 15% to 50%.

3.4 General Observations

It is known that the perception of odour is an ability that varies greatly within any group of people selected at random. That was true within the MOE monitoring crew, and it was true for the residents living within a few blocks of the Highland Creek valley near the S.T.P. The monitoring crew found that on the few occasions when odours were detected, they were fleeting in nature and weak in intensity. Some area residents found the odours more persistent and relatively strong while other residents showed little awareness of the same odours.

4.0 Conclusions

On the S.T.P. property odours were perceived by the monitoring crew every day of the survey period. The measured elevated concentrations of total reduced sulphur (TRS) compounds and total hydrocarbons (THC) indicated that the screen/degrit building (where raw sewage enters the S.T.P. complex) and the primary clarifiers were the most likely sources of odour. The sludge digesters showed lower values of TRS and the non-methane component of THC, while the secondary clarifiers showed generally low levels of all contaminants. Elevated levels of ozone were found on two occasions at the shoreline power site.

For most of the samples on S.T.P. property, the main TOC component found was toluene, however, always in concentrations well below the Ontario ½-hour point of impingement standard. Dichloromethane and 1,1,1-trichloroethane were found in some samples, especially near the screen building, but concentrations were far below the Ontario ½-hour standards. The only compound to exceed the ½-hour standard was 1,2,4-trimethylbenzene at the screen building with a concentration of 171 $\mu g/m^3$ (standard = 100 $\mu g/m^3$).

The plume from the incinerator stack was not accessible for monitoring during the survey period.

Monitoring in the residential areas north of the STP property showed low levels of all contaminants, except at times with contributions from local vehicle emissions.

Measurements during two periods downwind of Valspar, Inc. in the industrial area nearby showed toluene and xylenes to be the major contaminants at those times, but the concentrations did not exceed or approach Ontario's ½-hour standards.

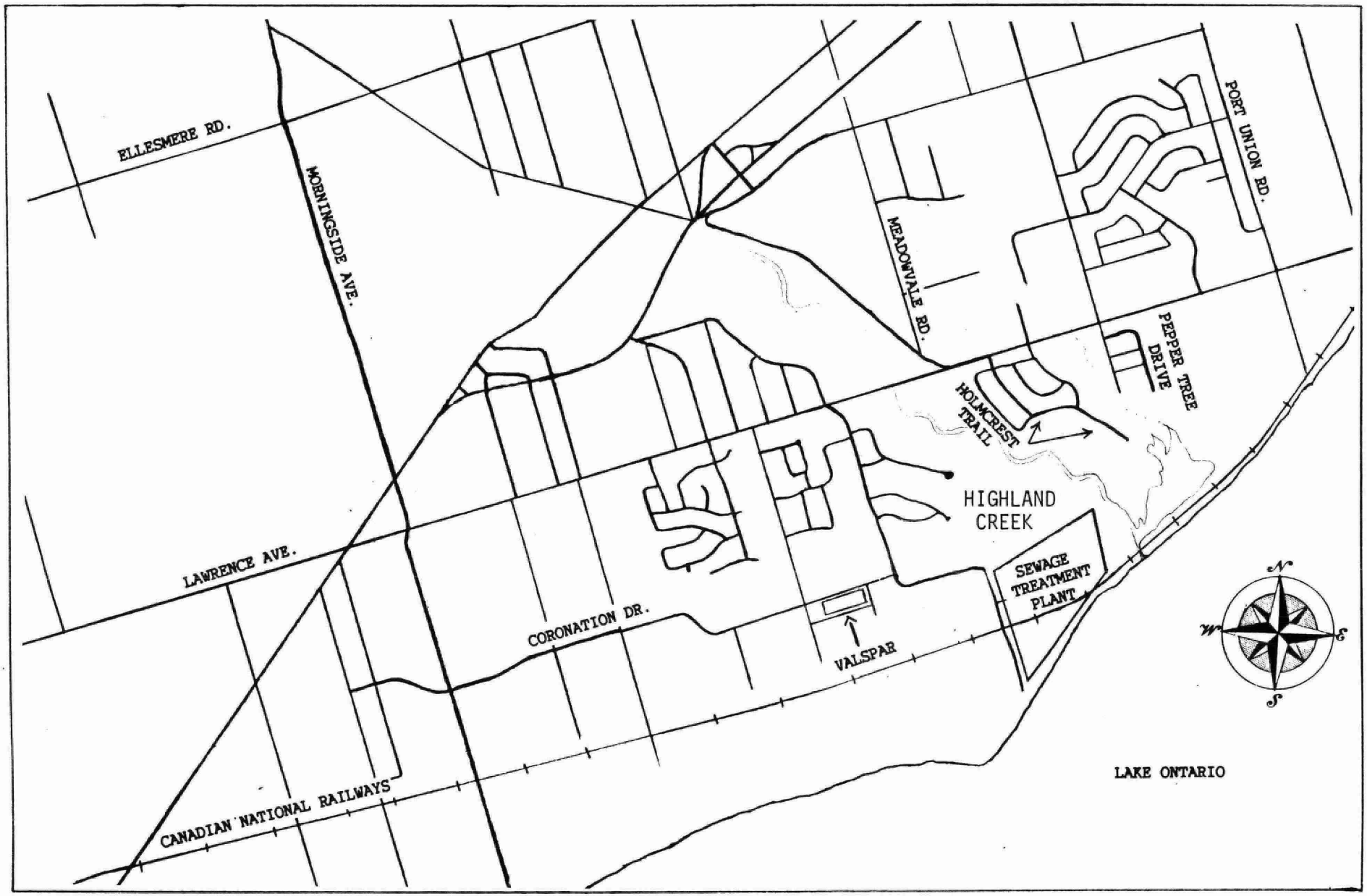

Figure 1. Highland Creek area.

Table 1
Monitoring Locations, Periods and Results Summary
(max. ½-hour average concentration)

Date 1987	Period # Time	Location	Comments	TRS ppm	CO ppm	O_3 ppm	THC ppm	TOC ug/m³
June 15	B151 12:55-15:21	14 Holmcrest Trail at S. end	mainly MAMu exhaust	0.002	2.6	0.05	2.0	1231, 522
15-16	B152 15:54-09:17	S.T.P. (shoreline)		0.006	0.8	0.05	3.0	-*
16	B163 12:11-13:41	S.T.P (shoreline)	secondary clarifier	0.002	0.3	0.05	0.7	103
16	B164 14:03-16:07	S.T.P., near NW group of primary sett./mech aeration	at S. edge of area, some sewage odour	0.006	0.6	0.02	1.3	181
16-17	B165 16:19-08:24	S.T.P. (shoreline)		0.002	2.7	0.05	3.1	-
17	B172 10:19-12:38	S.T.P., primary clarifier near digesters	wind from digester area, mainly methane	0.011	0.2	0.01	13.9	63, 27
17	B173 13:17-14:23	36 Holmcrest Trail	slight sewage odour at start of period	0.002	1.3	0.01	1.1	109
17	B174 15:20-16:40	S.T.P. (shoreline)		0.002	0.2	0.04	0.8	-
17-18	B178 23:00-08:15	S.T.P (shoreline)		0.002	2.1	n.d.	3.9	-

*TOC from gas chromatograph was not determined for overnight periods.

Table 1 (Cont'd)
Monitoring Locations, Periods and Results Summary

Date	Period # Time	Location	Comments	TRS ppm	CO ppm	O_3 ppm	THC ppm	TOC ug/m^3
June 18	B182 13:16-15:35	S.T.P. (shoreline)	secondary clarifier	0.002	0.1	0.03	1.1	59, 7
18-19	B183 15:35-08:15	S.T.P. (shoreline)		0.004	1.5	0.06	3.9	-
19	B192 09:42-16:08	Pepper Tree Drive (S. end)	Area residents detected odours	0.003	0.5	0.07	3.6	155, 215, 77
19-22	B193 16:36-08:23	S.T.P. (shoreline) over weekend		0.005	0.7	0.15	4.4	-
22	B221 10:48-12:05	S.T.P. primary clar. near digesters	Methane represented 80% THC	0.056	0.5	0.01	41.2	125
22	B222 12:26-14:50	S.T.P. primary clar. near screening building		0.040	1.1	0.01	17.5	170, 418
22-23	B223 15:35-07:55	S.T.P. (shoreline)		0.001	0.7	0.03	2.6	-
23	B232 11:03-13:27	S.T.P. primary clar near digesters	Methane represented 90% THC	0.031	0.4	0.02	48.0	170, 178
23	B233 14:01-15:11	S.T.P. screening build. at open door		0.052	0.5	0.03	5.8	1027
23-24	B234 15:23-07:59	S.T.P. (shoreline)		0.016	1.1	0.07	3.2	-

Table 1 (Cont'd)
Monitoring Locations, Periods and Results Summary

Date	Period # Time	Location	Comments	TRS ppm	CO ppm	O_3 ppm	THC ppm	TOC ug/m³
June 24	B242 10:46-12:28	Coronation Drive at Valspar		0.002	1.3	0.06	5.2	1190
24	B243 13:11-14:19	Holmcrest Trail, S. end	interference by gasoline vapours	0.002	1.0	0.06	-	-
24-25	B244 15:44-08:44	S.T.P. (shoreline)		0.006	1.7	0.07	4.8	-
25	B252 11:45-15:07	S.T.P. screening build. at open door		0.362	9.0	0.04	21.6	5339
25-26	B253 15:17-04:33	S.T.P. (shoreline)		0.007	0.7	0.11	2.0	-
26	B262 10:58-12:06	Coronation Drive at Valspar		0.001	1.7	0.01	4.5	1581

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TABLE 2

GC SAMPLES NEAR HIGHLAND CREEK JUNE 15-26,1987 All concentrations in units of ug/m3 (micrograms per cubic metre)

	30-MINUTE SAMPLE PERIOD ENDING .. PERIOD #	1987 JUN 15 13:04 B151	1987 JUN 15 14:24 B151	1987 JUN 16 11:23 B162	1987 JUN 16 12:43 B163	1987 JUN 16 14:27 B164	1987 JUN 17 10:45 B172	1987 JUN 17 11:56 B172	1987 JUN 17 13:46 B173	1987 JUN 18 13:45 B182	1987 JUN 18 14:58 B182	1987 JUN 19 10:09 B192	1987 JUN 19 11:19 B192	1987 JUN 19 12:24 B192	1987 JUN 22 11:16 B221	1987 JUN 22 12:54 B222	1987 JUN 22 14:11 B222	1987 JUN 23 11:35 B232	1987 JUN 23 12:58 B232	1987 JUN 23 14:32 B233	1987 JUN 24 11:14 B242	1987 JUN 25 12:03 B252	1987 JUN 26 11:27 B262
1	PROPANE	12.7	4.4	10.4	2.9	2.6	1.8	1.5	1.3	3.6		10.8	13.9	8.9	1.6	8.7	18.0	1.6	0.9	0.6	8.4	7.0	10.3
2	PROPADIENE																						
3	PROPYNE																						
4	CHLOROMETHANE																						
5	CYCLOPROPANE																						
6	2-METHYLPROPANE	115.9	35.4	8.3	2.5	4.0	1.4		7.8	3.9		7.5	12.8	3.8	1.2	2.4	17.4	1.0	1.1	3.5	4.6	19.6	15.1
7	CHLOROETHENE																						
8	1-BUTENE	50.8	18.0														6.3						
9	1,3-BUTADIENE																						
10	BUTANE	311.9	100.8	15.1	6.6	12.1	3.7	2.4	22.5	8.9	1.3	17.0	26.6	8.1	3.5	6.1	14.0	3.0	3.5	5.9	11.7	19.9	28.3
11	1-BUTYNE																						2.3
12	CHLOROETHANE																						
13	3-METHYL-1-BUTENE	6.5	2.0																				
14	2-METHYLBUTANE	218.0	65.6	14.7	5.3	10.0	3.3	2.5	17.2	10.7	1.0	18.1	27.8	7.6	4.0	7.0	14.1	2.4	3.2	5.7	10.7	25.2	26.1
15	2-METHYL-1-BUTENE	26.0	8.6						2.6				2.6				1.8						2.5
16	PENTANE	121.3	36.4	9.6	3.9	6.6	2.3	1.9	10.4	7.6	0.8	12.7	19.7	5.5	3.1	5.1	10.1	1.8	2.5	4.2	7.4	19.3	17.0
17	2-METHYL-1,3-BUTADIENE	6.3	9.1	1.9	2.8	6.0			4.5			2.4	3.8	3.6			1.7	1.5		2.9	1.5	4.9	2.6
18	trans-2-PENTENE	29.2	8.8			1.5			2.7	1.3		1.2	2.5				1.6					2.6	2.4
19	cis-2-PENTENE	13.0	3.9			0.7			1.1				1.0				1.3						1.0
20	DICHLOROMETHANE			5.5	10.0	9.4						3.8			7.0	6.7	14.2	3.6	7.6	55.4		193.7	
21	2-METHYL-2-BUTENE	41.8	11.9			2.0			3.4	1.6		1.6	3.1				1.7					4.3	3.3
22	2,2-DIMETHYLBUTANE	6.1	1.9										1.2							1.6		3.4	1.0
23	2-CHLORO-2-METHYLPROPANE																						
24	trans-1,2-DICHLOROETHENE																						
25	4-METHYL-1-PENTENE																						
26	3-METHYL-1-PENTENE																						
27	CYCLOPENTANE	9.7	3.1	1.2		0.9			1.2			1.3	2.0				1.2					2.7	1.6
28	2,3-DIMETHYLBUTANE	11.0	3.4	1.2		0.8			1.3			1.4	2.3				1.2			2.7	0.9	5.5	1.7

TABLE 2 cont.

GC SAMPLES NEAR HIGHLAND CREEK JUNE 15-26,1987 All concentrations in units of ug/m3 (micrograms per cubic metre)

	30-MINUTE	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987
	SAMPLE PERIOD	JUN 15	JUN 15	JUN 16	JUN 16	JUN 16	JUN 17	JUN 17	JUN 17	JUN 18	JUN 18	JUN 19	JUN 19	JUN 19	JUN 22	JUN 22	JUN 22	JUN 23	JUN 23	JUN 23	JUN 24	JUN 25	JUN 26
	ENDING ..	13:04	14:24	11:23	12:43	14:27	10:45	11:56	13:46	13:45	14:58	10:09	11:19	12:24	11:16	12:54	14:11	11:35	12:58	14:32	11:14	12:03	11:27
	PERIOD #	B151	B151	B162	B163	B164	B172	B172	B173	B182	B182	B192	B192	B192	B221	B222	B222	B232	B232	B233	B242	B252	B262
29	2-METHYLPENTANE	52.5	15.9	5.0	2.2	4.2	1.6	1.3	5.6	4.2		7.0	11.8	3.0	2.7	3.5	6.2	1.5	1.7	14.2	4.3	33.0	8.6
30	3-METHYLPENTANE	29.7	8.9	3.1	1.4	2.6	1.0	0.8	3.2	2.5		4.5	7.3	2.0	1.8	2.4	4.2	1.0	1.2	11.8	2.9	26.7	5.1
31	1-HEXENE	3.0	1.8																				
32	cis-1,2-DICHLOROETHENE																					11.9	
33	2-CHLOROBUTANE																						
34	HEXANE	35.6	10.9	4.5	2.1	3.5	1.5	1.3	4.0	3.4		6.9	10.3	3.0	3.1	4.3	6.1	1.8	2.0	21.0	4.9	46.8	7.3
35	TRICHLOROMETHANE																						
36	trans-3-HEXENE	0.9																					
37	1-CHLORO-2-METHYLPENTANE																						
38	3-CHLORO-2-METHYLPROPENE																						
39	1-CHLORO-2-METHYLPROPANE																						
40	2,2-DIMETHYLPENTANE	0.9																		1.5		2.5	
41	METHYLCYCLOPENTANE	12.1	3.6	1.7		1.4			1.5	1.2		2.2	3.6	1.0	0.9	1.1	1.9			2.9	1.6	8.8	2.3
42	1,2-DICHLOROETHANE																						
43	2,4-DIMETHYLPENTANE	3.9	1.2										1.0							1.7		4.1	
44	1,1,1-TRICHLOROETHANE		4.3	12.0	14.2	21.6	4.7					4.0	4.5	5.4	9.1	19.5	58.4	17.8	15.8	175.5		716.6	
45	1-CHLOROBUTANE																						
46	BENZENE	31.2	16.9	7.0	5.0	6.7	2.2	1.8	3.8	2.0	1.2	4.6	5.5	3.1	2.3	2.8	3.7	2.0	2.4	3.2	4.5	12.6	5.2
47	TETRACHLOROMETHANE																			26.6	18.7	56.4	
48	3,3-DIMETHYLPENTANE	2.7																		0.8		2.1	
49	CYCLOHEXANE	2.1											1.0									1.9	
50	2-METHYLHEXANE	6.9	2.6	1.4		1.3			1.1	0.9		1.8	3.0	0.9	1.2	1.1	1.9	0.9	0.9	7.4	4.6	16.7	2.5
51	2,3-DIMETHYLPENTANE	3.4	1.1										1.1							3.4	2.0	7.7	
52	CYCLOHEXENE																						
53	3-METHYLHEXANE	8.1	3.0	1.7	0.8	1.6			1.2	1.0		2.1	3.2	1.2	1.4	1.3	2.5	1.2	1.2	11.1	7.2	25.1	4.0
54	DIBROMOMETHANE																						
55	1,2-DICHLOROPROPANE																						
56	2,3-DICHLOROPROPENE																				2.2		

TABLE 2 cont.

GC SAMPLES NEAR HIGHLAND CREEK JUNE 15-26,1987 All concentrations in units of ug/m3 (micrograms per cubic metre)

	30-MINUTE SAMPLE PERIOD ENDING .. PERIOD #	1987 JUN 15 13:04 B151	1987 JUN 15 14:24 B151	1987 JUN 16 11:23 B162	1987 JUN 16 12:43 B163	1987 JUN 16 14:27 B164	1987 JUN 17 10:45 B172	1987 JUN 17 11:56 B172	1987 JUN 17 13:46 B173	1987 JUN 18 13:45 B182	1987 JUN 18 14:58 B182	1987 JUN 19 10:09 B192	1987 JUN 19 11:19 B192	1987 JUN 19 12:24 B192	1987 JUN 22 11:16 B221	1987 JUN 22 12:54 B222	1987 JUN 22 14:11 B222	1987 JUN 23 11:35 B232	1987 JUN 23 12:58 B232	1987 JUN 23 14:32 B233	1987 JUN 24 11:14 B242	1987 JUN 25 12:03 B252	1987 JUN 26 11:27 B262
57	TRICHLOROETHENE															7.5			6.8		45.0	
58	1-HEPTENE	1.2	2.1			1.2													1.7	1.4	3.0	1.8
59	2,2,4-TRIMETHYLPENTANE	4.9	2.6	1.4		1.4						1.8	2.3				1.7	1.0	1.0		2.9	4.0	
60	HEPTANE	4.5	2.7	1.5	1.4	1.4	0.8					2.0	2.6	1.1	2.2	1.3	2.9	2.1	1.8	11.1	16.1	31.1	20.1
61	trans-2-HEPTENE																						
62	METHYLCYCLOHEXANE	2.3	1.3	1.5	2.8		0.8					1.5	1.6		3.1	2.2	9.6	2.4	1.9	11.9	34.9	56.0	53.8
63	2,2-DIMETHYLHEXANE																						
64	2,5-DIMETHYLHEXANE																						
65	ETHYLCYCLOPENTANE																0.3			0.4	1.0	2.0	1.5
66	4-METHYLCYCLOHEXENE																						
67	1-CHLOROPENTANE																						
68	1,1,2-TRICHLOROETHANE																						
69	2,3,4-TRIMETHYLPENTANE	1.8																					
70	TOLUENE	20.4	17.7	17.4	11.8	15.0	18.9	4.9	4.7	4.0	2.0	14.0	15.3	9.5	30.2	46.5	35.4	36.7	37.6	48.2	198.9	296.1	26.3
71	1,3-DICHLOROPROPANE																						
72	2-METHYLHEPTANE	1.9	1.7	0.9	2.4		1.3					1.2	1.5		4.7	1.9	5.1	4.8	4.3	20.7	34.1	89.7	50.9
73	4-METHYLHEPTANE																1.8					15.2	8.3
74	3-METHYLHEPTANE	2.1														1.3			2.4	11.9	19.8	57.7	7.3
75	c-1,3-DIMETHYLCYCLOHEXANE		0.7		1.1		0.9								1.8	0.9	4.7	1.8	1.5	8.4	15.4	41.4	22.9
76	1,2-DIBROMOETHANE																						
77	1-OCTENE		2.6			1.1									1.5	1.2	3.0	2.1	1.8	3.3	3.1	15.9	6.8
78	1,1-DIMETHYLCYCLOHEXANE														0.8	0.6	1.7	1.2	1.0	3.1	4.4		6.9
79	trans-4-OCTENE																						
80	OCTANE	1.3	2.2	1.4	3.4	1.1	2.3					1.5	1.4	1.0	7.1	2.6	8.4	8.6	7.2	38.1	53.8	177.1	74.6
81	trans12DIMETHYLCYCLOHEXAN				0.4										0.7	0.4	2.3	0.7	0.6	3.8	6.0	18.0	8.7
82	c-1,4-DIMETHYLCYCLOHEXANE																						
83	TETRACHLOROETHENE																6.6		4.3	31.2	11.3	61.3	13.4
84	2-OCTENE																						

TABLE 2 cont.

GC SAMPLES NEAR HIGHLAND CREEK JUNE 15-26,1987 All concentrations in units of ug/m3 (micrograms per cubic metre)

	30-MINUTE	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987
	SAMPLE PERIOD	JUN 15	JUN 15	JUN 16	JUN 16	JUN 16	JUN 17	JUN 17	JUN 17	JUN 18	JUN 18	JUN 19	JUN 19	JUN 19	JUN 22	JUN 22	JUN 22	JUN 23	JUN 23	JUN 23	JUN 24	JUN 25	JUN 26
	ENDING ..	13:04	14:24	11:23	12:43	14:27	10:45	11:56	13:46	13:45	14:58	10:09	11:19	12:24	11:16	12:54	14:11	11:35	12:58	14:32	11:14	12:03	11:27
	PERIOD #	B151	B151	B162	B163	B164	B172	B172	B173	B182	B182	B192	B192	B192	B221	B222	B222	B232	B232	B233	B242	B252	B262
85	trans-2-OCTENE				0.6										0.5	0.7	1.4	0.5	0.4	2.6	4.2	13.6	6.2
86	cis12DIMETHYLCYCLOHEXANE																						
87	CHLOROBENZENE																					39.4	
88	ETHYLCYCLOHEXANE				1.9		1.1											2.8	2.3	16.0	22.9	88.8	31.4
89	1-CHLOROHEXANE		2.7														4.3	3.1		9.5	4.6		6.8
90	ETHYLBENZENE	2.8	4.4	3.0	2.0	2.5	1.1	0.8	0.8			2.8	2.5	1.7	1.6	4.2	6.4	1.1	1.3	13.0	75.0	46.0	142.5
91	m-XYLENE & p-XYLENE	8.6	15.9	6.6	4.7	8.3	3.2	2.1	2.2	1.6		7.5	6.5	4.2	8.7	11.8	14.7	4.1	5.0	18.0	246.1	85.0	471.7
92	p-XYLENE																						
93	4-METHYLOCTANE																	2.5	2.2	18.0		45.0	
94	2-METHYLOCTANE																	3.4	2.5	2.2			
95	3-METHYLOCTANE																	2.5	2.2	17.5	17.6	45.0	21.4
96	STYRENE																						
97	1,4-DICHLOROBUTANE																				16.8		19.7
98	1,1,2,2-TETRACHLOROETHANE																						
99	o-XYLENE	3.2	6.4	2.5	1.3	3.6	1.4	0.9	1.0	0.8		2.5	2.3	1.5	2.8	3.5	5.0	1.9	2.5	8.0	29.3	59.0	61.6
100	1-NONENE																	1.9	1.7	13.0	12.3	66.2	13.3
101	1,2,3-TRICHLOROPROPANE																						
102	trans-1,4-DICL-2-BUTENE																4.7				15.1		14.2
103	NONANE		2.5	1.3	2.5	1.4	1.7					1.2	1.1		3.0	4.0	14.4	7.6	6.9	60.0	45.8	288.8	43.9
104	ISOPROPYLBENZENE																		1.1		5.7		6.3
105	2-CHLOROTOLUENE																					116.7	
106	3-CHLOROTOLUENE																					145.3	
107	PROPYLBENZENE		2.6			2.0	1.0						1.0				4.0	2.3	2.9	17.0		98.7	11.9
108	4-CHLOROTOLUENE																						
109	3-ETHYLTOLUENE		6.9	1.4	1.5	4.1		0.9	0.9			1.9	1.6		3.5		7.0	4.0	5.7	27.0	21.3	257.2	32.2
110	4-ETHYLTOLUENE		3.4			1.8											6.3	2.2	2.4	15.0	8.6	86.9	15.0
111	1,3,5-TRIMETHYLBENZENE	0.8	3.8			2.3	1.3								1.7	1.1	6.8	1.6	2.0	10.0	9.7	88.3	12.3
112	2-ETHYLTOLUENE		2.7			1.6									1.2	1.2	3.0	1.5	1.9	6.7	8.7	72.7	11.2

TABLE 2 cont.

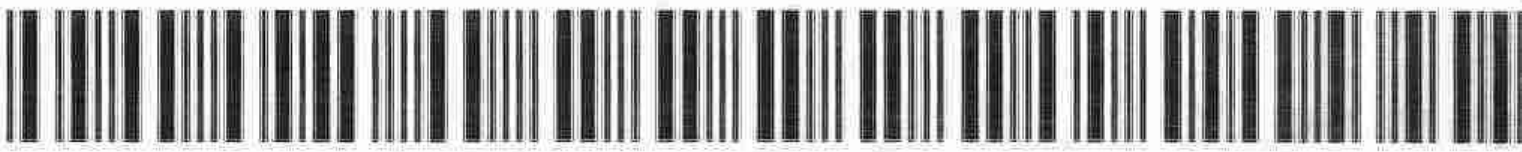
GC SAMPLES NEAR HIGHLAND CREEK JUNE 15-26,1987 All concentrations in units of ug/m3 (micrograms per cubic metre)

	30-MINUTE	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987
	SAMPLE PERIOD	JUN 15	JUN 15	JUN 16	JUN 16	JUN 16	JUN 17	JUN 17	JUN 17	JUN 18	JUN 18	JUN 19	JUN 19	JUN 19	JUN 22	JUN 22	JUN 22	JUN 23	JUN 23	JUN 23	JUN 24	JUN 25	JUN 26
	ENDING ..	13:04	14:24	11:23	12:43	14:27	10:45	11:56	13:46	13:45	14:58	10:09	11:19	12:24	11:16	12:54	14:11	11:35	12:58	14:32	11:14	12:03	11:27
	PERIOD #	B151	B151	B162	B163	B164	B172	B172	B173	B182	B182	B192	B192	B192	B221	B222	B222	B232	B232	B233	B242	B252	B262
113	1-DECENE																					226.3	
114	tert.BUTYLBENZENE	0.6	3.5	0.9	1.0	2.2	0.9	0.4	0.8			0.4	0.9	0.5		0.9	2.4	1.3	1.5	7.3	8.8	52.2	
115	1,2,4-TRIMETHYLBENZENE		11.4	1.5	1.6	7.1		1.4				1.6	1.4	0.8	3.0	3.1	8.7	4.9	5.5	25.4	32.1	171.4	34.8
116	1,3-DICHLOROBENZENE																			11.4	5.1	51.3	
117	tertBUTYLCYCLOHEXANE																			3.3		87.0	
118	(CHLOROMETHYL)BENZENE																					75.9	
119	DECANE		4.5	1.7	2.0	3.1	1.7	0.9				1.5	1.1			3.2	13.7	4.4	4.2	51.5	35.0	293.2	7.7
120	1,5-DICHLOROPENTANE																2.1			8.3		42.1	
121	isoBUTYLBENZENE																						
122	3-(CHLOROMETHYL)HEPTANE																					27.8	
123	sec.BUTYLBENZENE																				0.9		
124	1,2,3-TRIMETHYLBENZENE		4.3			2.7	1.3								1.4	1.6	4.2	2.3	2.2	11.6	14.9	69.7	8.8
125	1ISOPROPYL4METHYLBENZENE																2.4			9.3			
126	1,2-DICHLOROBENZENE																4.9			14.7			
127	INDAN		2.2																				2.8
128	BUTYLCYCLOHEXANE																3.7			14.2	7.4	62.1	
129	1,3-DIETHYLBENZENE																					20.8	
130	1,4-DIETHYLBENZENE																					67.2	
131	BUTYLBENZENE		3.8			2.5											3.2	1.8	2.0	11.0	9.1	64.7	4.2
132	1,2-DIETHYLBENZENE																			4.7		16.3	
133	transDECAHYDRONAPHTHALENE																1.3			4.6	2.3	41.1	
134	UNDECANE	1.0	6.0	1.6	1.2	3.9			1.1			1.4	0.8		1.7	3.3	9.8	5.6	5.4	25.5	20.3	109.0	3.8
135	cis-DECAHYDRONAPHTHALENE																						
136	1235-TETRAMETHYLBENZENE		3.6			2.6															3.9		
137	1234-TETRAMETHYLBENZENE		4.2			3.1															2.9	7.6	
138	1234TETRAHYDRONAPHTHALENE																						
139	1,4-DIISOPROPYLBENZENE																						
140	NAPHTHALENE																						
141	DODECANE	1.2	10.8	1.6		5.9		1.4	1.5		0.9	1.6			1.1	1.5	3.4	4.1	4.8	6.0	2.6	16.7	1.3

TABLE 2 cont.

GC SAMPLES NEAR HIGHLAND CREEK JUNE 15-26,1987 All concentrations in units of ug/m3 (micrograms per cubic metre)

30-MINUTE	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987	1987
SAMPLE PERIOD	JUN 15	JUN 15	JUN 16	JUN 16	JUN 16	JUN 17	JUN 17	JUN 17	JUN 18	JUN 18	JUN 19	JUN 19	JUN 19	JUN 22	JUN 22	JUN 22	JUN 23	JUN 23	JUN 23	JUN 24	JUN 25	JUN 26
ENDING ..	13:04	14:24	11:23	12:43	14:27	10:45	11:56	13:46	13:45	14:58	10:09	11:19	12:24	11:16	12:54	14:11	11:35	12:58	14:32	11:14	12:03	11:27
PERIOD #	B151	B151	B162	B163	B164	B172	B172	B173	B182	B182	B192	B192	B192	B221	B222	B222	B232	B232	B233	B242	B252	B262
Total Compounds Identified	46	55	34	32	45	27	14	27	18	7	36	41	20	34	36	57	48	49	63	62	81	62
Total # of Peaks	63	92	39	40	66	36	23	36	25	13	43	48	30	57	53	105	70	70	129	117	145	98
Total Area of Peaks	33995	16164	4793	2530	6094	2048	958	3201	1886	447	4138	5741	2103	4051	4571	12389	4976	5042	28940	39359	72227	43556
Area of Identified Peaks	30515	12252	3557	2250	3897	1634	700	2664	1590	241	3757	5201	1876	3000	4000	9200	3863	4023	21200	31299	60000	37476
Area % Identified Peaks	90	76	74	89	64	80	73	83	84	54	91	91	89	74	88	74	78	80	73	80	83	86
Total Hydrocarbons (ug/m3)	1231.5	522.3	150.3	103.1	181.3	63.2	26.9	109.2	59.0	7.2	155.3	215.2	77.4	125.0	170.7	418.1	169.8	178.0	1026.5	1190.1	5339.1	1438.0
Alkanes (ug/m3)	959.1	324.1	86.3	40.5	67.4	24.3	13.8	78.2	46.6	4.0	102.0	152.8	46.0	43.4	61.0	156.6	62.8	63.1	359.7	317.6	1436.9	366.3
Cycloalkanes (ug/m3)	26.2	8.8	4.4	6.2	2.3	2.8	0.0	2.7	1.2	0.0	5.0	8.2	1.0	7.3	5.2	25.3	8.9	7.3	64.0	93.5	368.7	129.0
Alkenes (ug/m3)	178.6	68.7	1.9	3.3	12.5	0.0	0.0	14.2	2.8	0.0	5.2	12.9	3.6	2.0	1.8	18.8	6.0	3.9	23.6	22.6	336.7	39.9
Cycloalkenes (ug/m3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkynes (ug/m3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
Aromatics (ug/m3)	67.5	113.8	40.2	28.8	68.1	31.3	13.1	14.1	8.4	3.2	35.4	36.8	21.4	56.3	76.5	114.5	67.7	76.0	239.9	682.5	1613.5	846.5
Chlorinated Alkanes (ug/m3)	1.2	9.0	17.5	24.2	32.2	4.7	0.0	0.0	0.0	0.0	7.8	4.5	5.4	16.0	26.2	79.0	24.4	23.4	277.0	41.5	1039.5	28.3
Chlorinated Alkenes (ug/m3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	0.0	4.3	38.0	28.6	118.2	27.6
Chlorinated Aromatics(ug/m3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	0.0	0.0	34.4	5.1	394.8	0.0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